P
Technical
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C.L. 3750.

INTERIM

MEMORANDUM

ON

FRENCH METRIC SCREW THREADS

FOR

AIRCRAFT PURPOSES

PREPARED BY REQUEST

BY

THE BRITISH ENGINEERING STANDARDS COMMITTEE.

UNIVERSITY OF TORONTO
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August, 1917.

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The system of Screw Threads for Aircraft purposes recommended by the Chambre Syndicale des Industries Aéronautiques with the approval of the French Military aviation authorities was brought to the notice of the British Engineering Standards Committee by the Naval and Military Air Services, and the Committee was asked to advise as to suitable limits to be used in the manufacture of such Screws, and as to dimensions for hexagon heads and nuts for use therewith.

The following Memorandum has accordingly been prepared by the Committee for the convenience of manufacturers and others using these threads.

Form of Thread.

The form of thread is shown in fig. 1 and the engagement of two threads in fig. 2. The form is that of the *Système International*.

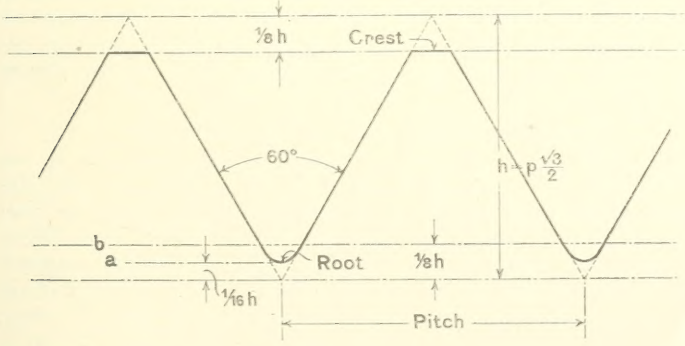

FIG. 1. FORM OF THREAD

The thread angle is 60°, the crest of the thread is cylindrical and lies at a distance of $\frac{1}{8}$ **h** from the vertex of the complete triangle in fig. 1, while the root of the thread is curved in section in such a way that the curve lies wholly between the two lines **a b** in fig. 1 situated respectively $\frac{1}{16}$ **h** and $\frac{1}{8}$ **h** above the base of the triangle. The exact curvature of the root is immaterial, but, in order to provide for the inevitable wear of tools and to keep the work within the tolerances specified in the tables, it may be found desirable to have the threading tools, when new, somewhat flat crested. The corners will rapidly wear off, thus producing in the work the rounded form shown in the figures.

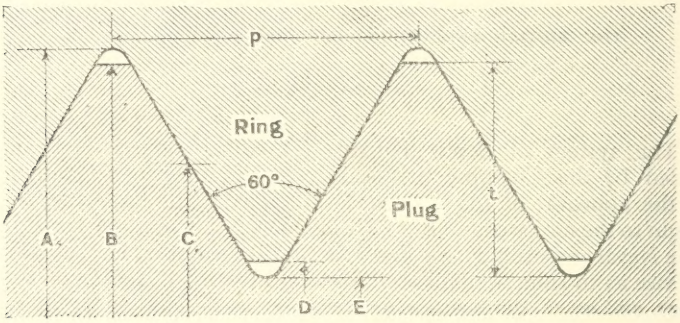

FIG. 2. THEORETICAL DIMENSIONS OF STANDARD THREAD.

Dimensions of the Screws.

The dimensions of the screws with the permissible limits for full, core and effective diameters and pitches are given in Tables 2 and 3, and the figures in the tables are to be worked to in all cases where these threads are employed.

Tolerances are provided for two different grades of work, namely, first grade and second grade. The second grade tolerances are suitable for ordinary bolts and nuts, while the finer tolerances are provided for cases such as aircraft engine work, where greater accuracy is required.

Tolerance in Pitch and Effective Diameter.

When the pitch of a screw thread is either greater or less than the Standard pitch, then, if it be on a plug, the effective diameter of the screw must be made less than the maximum in order to ensure that the screw shall enter a normal tapped hole freely. The converse is true of the thread in the hole, the effective diameter of which must be larger than the minimum if the pitch be in error. Error of pitch, therefore, involves tolerance on effective diameter, and the total tolerance on effective diameter must be sufficient to cover both error of pitch and error of effective diameter *per se*. Thus, if in any screw the effective diameter reaches the maximum,

no pitch error is permissible. Similarly, if the pitch error reach the maximum, the effective diameter must, in the case of the plug, be the minimum allowed, or, in the case of the ring, it must be the maximum. The tolerances on pitch given in the tables are based in this way upon the tolerances given on effective diameter, and are obtained by multiplying the latter by 0·577, which is the tangent of half the thread-angle (60°). Errors of pitch, positive and negative alike, require compensating tolerances on effective diameter, and the pitch tolerances given in the tables may be regarded as either plus or minus. Each pitch tolerance given in the tables is the maximum departure from their nominal distance which can be permitted between any two points on the thread within the length of engagement. In ordinary cases this length may be taken as the nut thickness.

It must also be noted that if there be an error in the angle of the thread a reduction in the effective diameter is required to compensate this.

TABLE 1.

THEORETICAL DIMENSIONS OF STANDARD THREAD.

(SEE FIG. 2.)

1	2	3	4	5	6	7	8	9
Nominal Size.	Pitch. p.	Depth of thread. t.	Full Diameter. Ring. A	Full Diameter. Plug. B	Effective Diameter. C	Core Diameter. Ring. D	Core Diameter. Plug. E	Cross Sectional Area at E
mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm².
3	·600	·423	3·065	3·000	2·610	2·220	2·155	3·65
4	·750	·528	4·081	4·000	3·513	3·026	2·944	6·81
5	·750	·528	5·081	5·000	4·513	4·026	3·944	12·2
6	1·000	·704	6·108	6·000	5·351	4·701	4·593	16·6
7	1·000	·704	7·108	7·000	6·351	5·701	5·593	24·6
8	1·250	·880	8·135	8·000	7·188	6·376	6·240	30·6
9	1·250	·880	9·135	9·000	8·188	7·376	7·240	41·2
10	1·500	1·055	10·162	10·000	9·026	8·052	7·889	48·9
11	1·500	1·055	11·162	11·000	10·026	9·052	8·889	62·1
12	1·750	1·232	12·190	12·000	10·863	9·726	9·537	71·4

TABLE 2.

LIMITS OF SIZE FOR SCREWS.

1	2	3	4	5	6	7	8	9	10	11	12
Nominal Size.	Full Diameter.			Pitch.			Effective Diameter.			Core Diameter.	
	Max.	First Grade. Min.	Second Grade. Min.	Standard.	Tolerance. First Grade.	Tolerance. Second Grade.	Max.	First Grade. Min.	Second Grade. Min.	Min.	First or Second Grade Max.
mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
3	3·00	2·84	2·78	·60	·046	·092	2·61	2·53	2·45	2·00	2·22
4	4·00	3·84	3·78	·75	·046	·092	3·51	3·43	3·35	2·80	3·02
5	5·00	4·84	4·78	·75	·046	·092	4·51	4·43	4·35	3·80	4·02
6	6·00	5·84	5·74	1·00	·046	·092	5·35	5·27	5·19	4·44	4·70
7	7·00	6·84	6·74	1·00	·046	·092	6·35	6·27	6·19	5·44	5·70
8	8·00	7·80	7·70	1·25	·058	·115	7·19	7·09	6·99	6·06	6·36
9	9·00	8·80	8·70	1·25	·058	·115	8·19	8·09	7·99	7·06	7·36
10	10·00	9·80	9·64	1·50	·058	·115	9·03	8·93	8·83	7·68	8·04
11	11·00	10·80	10·64	1·50	·058	·115	10·03	9·93	9·83	8·68	9·04
12	12·00	11·80	11·60	1·75	·058	·115	10·86	10·76	10·66	9·32	9·72

Note on Pitches (Column 5).—The Pitches of the 3 and 4 mm. Screws are those recommended by the Société d'Encouragement pour l'Industrie Nationale in 1905, but the Pitch of the 5 mm. Screw is somewhat finer than the 0·90 mm. pitch recommended by the Société. The intermediate 0·5 millimetre sizes between the 3 and 6 mm. screws are omitted. The pitches of the screws from 6 mm. to 12 mm. inclusive are those of the Système International.

TABLE 3.

LIMITS OF SIZE FOR SCREW THREADS IN NUTS AND TAPPED HOLES.

1	2	3	4	5	6	7	8	9	10	11	12
Nominal Size.	Full Diameter.		Pitch.			Effective Diameter.			Core Diameter.		
	Max.	First or Second Grade. Min.	Standard.	Tolerance. First Grade.	Tolerance. Second Grade.	Min.	First Grade. Max.	Second Grade. Max.	Min.	First Grade. Max.	Second Grade. Max.
mm.	mm.	mm.	mm.	mm.	mm.	mm	mm.	mm.	mm.	mm.	mm.
3	3·24	3·02	·60	·046	·092	2·63	2·71	2·79	2·24	2·40	2·46
4	4·24	4·02	·75	·046	·092	3·53	3·61	3·69	3·04	3·20	3·26
5	5·24	5·02	·75	·046	·092	4·53	4·61	4·69	4·04	4·20	4·26
6	6·28	6·02	1·00	·046	·092	5·37	5·45	5·53	4·72	4·88	4·98
7	7·28	7·02	1·00	·046	·092	6·37	6·45	6·53	5·72	5·88	5·98
8	8·32	8·02	1·25	058	·115	7·21	7·31	7·41	6·38	6·58	6·68
9	9·32	9·02	1·25	·058	·115	8·21	8·31	8·41	7·38	7·58	7·68
10	10·38	10·02	1·50	·058	·115	9·05	9·15	9·25	8·06	8·26	8·42
11	11·38	11·02	1·50	·058	·115	10·05	10·15	10·25	9·06	9·26	9·42
12	12·42	12·02	1·75	·058	·115	10·88	10·98	11·08	9·74	9·94	10·14

[C.L. 3750.]

Hexagon Nuts and Bolt Heads.

Dimensions for Hexagon Nuts and Bolt Heads have also been given by the Chambre Syndicale des Industries Aéronautiques, but materials and wrenches for these are not readily obtainable in this country. To meet this difficulty hexagons already employed for British Standard Automobile Nuts have been adopted for the Screws from 7 mm. to 12 mm. diameter, while, for the screws from 3 mm. to 6 mm. diameter, hexagons are taken from the list which it is proposed to recommend for the heads of British Association Screws. The dimensions of Hexagon Nuts and Bolt Heads now recommended are given in Table 4.

TABLE 4.

DIMENSIONS OF HEXAGON NUTS, LOCK NUTS AND BOLT HEADS.

1	2	3	4	5	6	7	8	9
Diameter of Bolt.	Width across Flats.		Thickness.					
			Nuts.		Lock Nuts.		Bolt Heads.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
mm	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.
3	·188	·183	·12	·11	·08	·07	·10	·09
4	·280	·275	·15	·14	·10	·09	·14	·13
5	·338	·333	·19	·18	·13	·12	·17	·16
6	·406	·401	·22	·21	·15	·14	·20	·19
7	·445	·440	·26	·25	·18	·17	·23	·22
8	·525	·520	·29	·28	·20	·19	·26	·25
9	·600	·595	·33	·32	·22	·21	·29	·28
10	·710	·705	·37	·36	·25	·24	·33	·32
11	·710	·705	·40	·39	·27	·26	·36	·35
12	·820	·815	·44	·43	·29	·28	·39	·38

APPENDIX.

NOTE BY THE NATIONAL PHYSICAL LABORATORY ON THE RELATION OF TOTAL TOLERANCE ON PITCH TO TOLERANCE PER THREAD OR PER INCH (OR MILLIMETRE) ON EITHER BOLT OR NUT.

The tolerance on pitch obtained by multiplying the tolerance on effective diameter by $\tan \frac{\alpha}{2}$ is the total permissible error P in pitch on the length of thread engaged. It is sometimes useful to know the tolerance per thread or per inch (or millimetre). Let P be the pitch tolerance as defined above, p the tolerance on one thread, n the number of threads engaged, and N the number of threads per inch (or millimetre). Then clearly the tolerance on n threads is np, and this is the total tolerance P.

Hence— $$np = P$$
$$p = \frac{P}{n}$$

One inch (or millimetre) contains N threads, so that the tolerance on one inch (or millimetre) is Np, or when n threads are engaged $\frac{NP}{n}$.

Again, if δ be the tolerance on effective diameter—

$$P = \delta \tan \frac{\alpha}{2}.$$

Thus the tolerance per pitch when n threads are engaged is—

$$\frac{1}{n} \delta \tan \frac{\alpha}{2}$$

and the tolerance per inch (or millimetre) under the same conditions is—

$$\frac{N}{n} \delta \tan \frac{\alpha}{2}.$$

These results may be expressed in terms of the thickness of the nut t, thus—

The number of threads per inch (or millimetre) is N, hence the pitch (the distance between two threads) is $\frac{1}{N}$, and since the nut contains n threads, its thickness is $\frac{n}{N}$.

Hence $t = \frac{n}{N}$,

and $$n = N\,t.$$

Thus the tolerance per thread for a nut of thickness t is $\frac{\delta}{Nt} \tan \frac{\alpha}{2}$, and the tolerance per inch (or millimetre) is $\frac{\delta}{t} \tan \frac{\alpha}{2}$.

The pitch tolerance per inch (or millimetre) depends solely on the effective diameter tolerance, the angle of the thread, and the thickness of the nut.

British Engineering Standards Committee.

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OF

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FEBRUARY, 1918.

(*This List cancels all previous Lists.*)

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